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THE

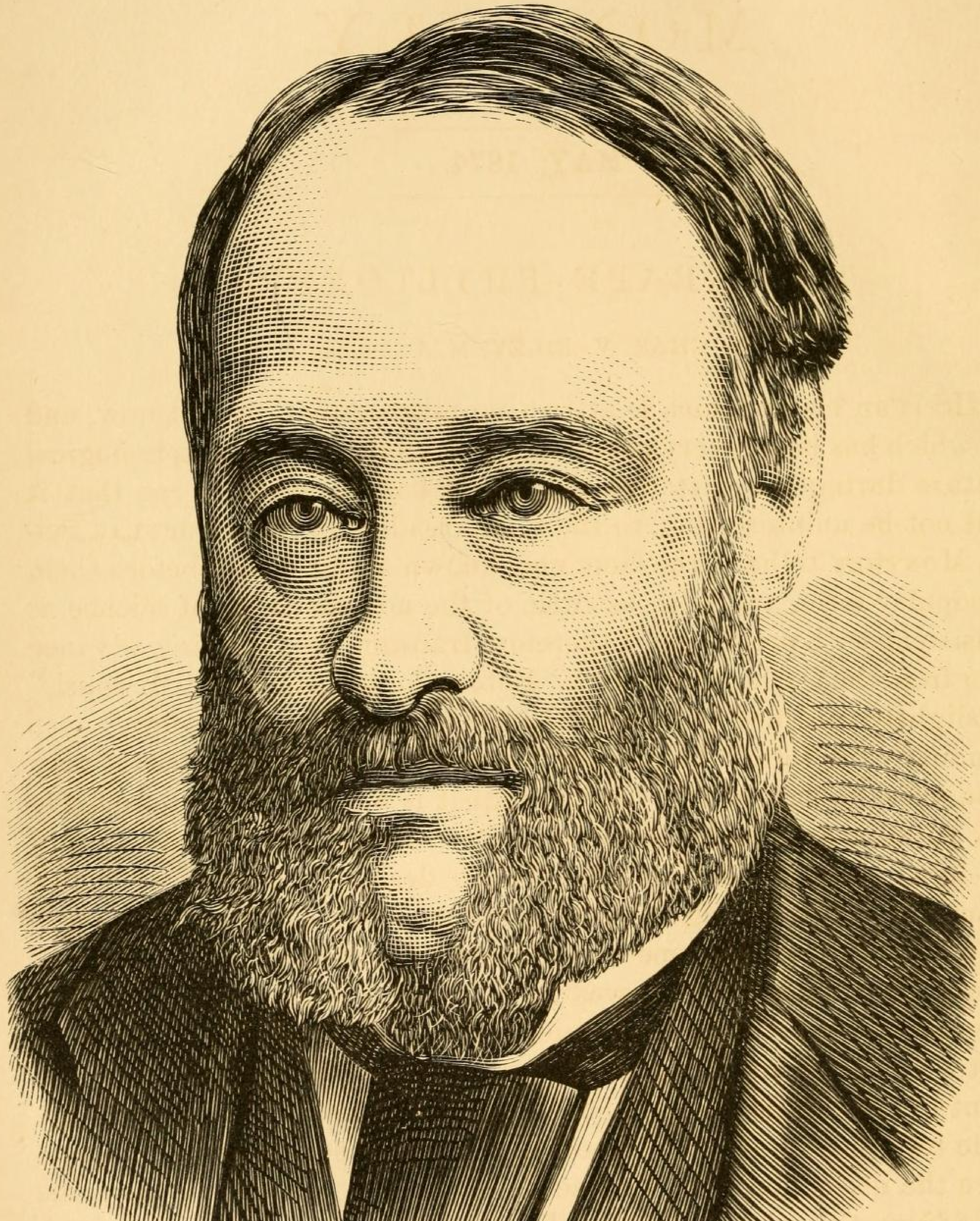
POPULAR SCIENCE MONTHLY.

CONDUCTED BY E. L. YOUMANS.

VOL. V.

MAY TO OCTOBER, 1874.

NEW YORK:
D. APPLETON AND COMPANY,
549 & 551 BROADWAY.
1874.



JAMES PRESCOTT JOULE.

THE AQUARIUM.

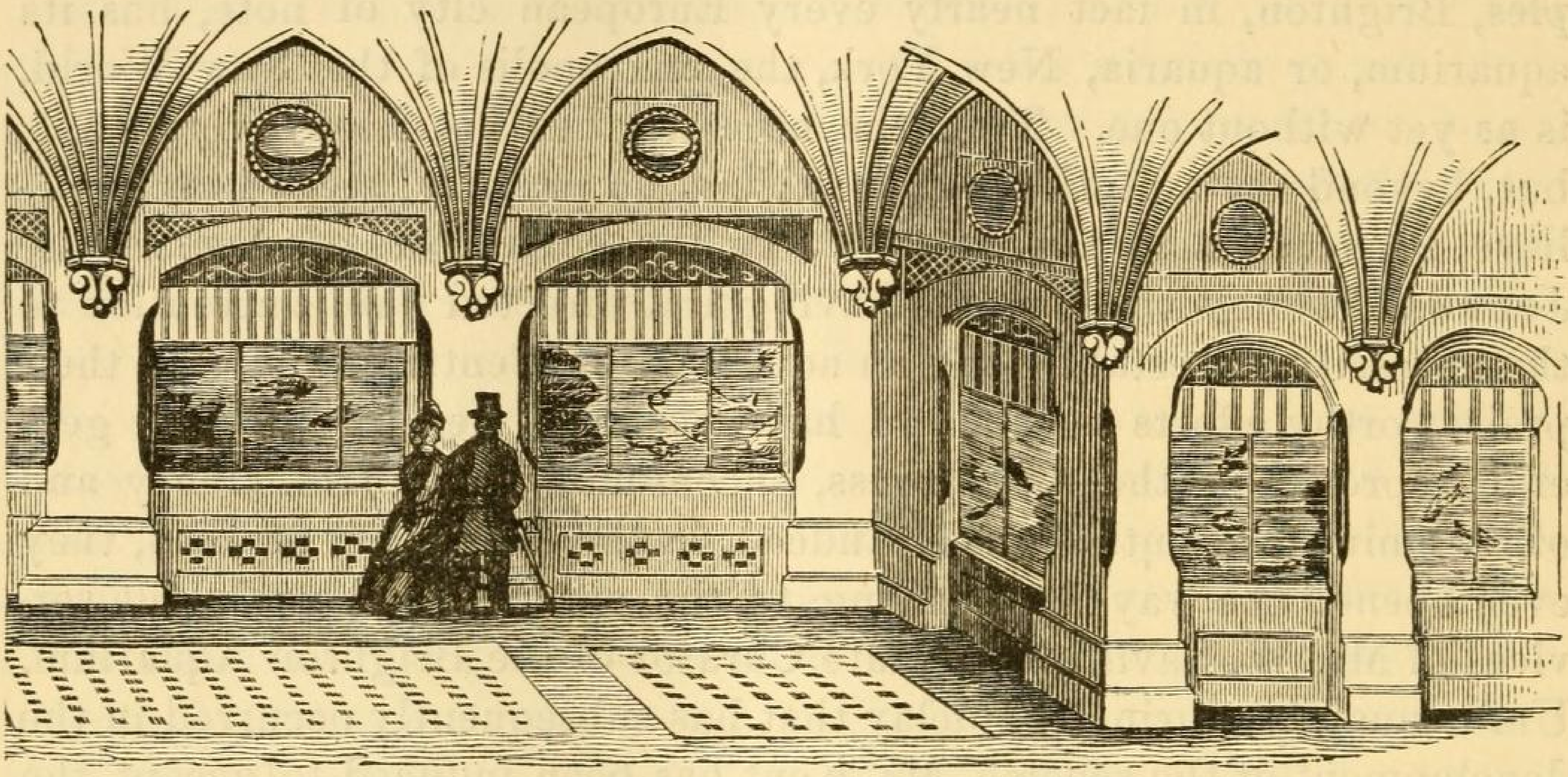
By WILLIAM E. SIMMONS, Jr.

IT is a subject for regret, as well from a national as a scientific point of view, that, while London, Paris, Berlin, Hamburg, Naples, Brighton, in fact nearly every European city of note, has its aquarium, or aquaria, New York, the metropolis of the New World, is as yet without one. True, the necessity has not been overlooked; but, beyond the agitation of the subject, no practical steps have, I believe, been taken in the matter. To the conductors of Appletons' Journal belongs the honor of having first directed public attention to the necessity for establishing an aquarium at Central Park, and their praiseworthy efforts to that end have received, besides the very general approval of the daily press, encomiums from Prof. Henry and other eminent scientific men. Indeed, in the latter part of 1873, they even opened the way for securing to the enterprise the valuable services of Mr. W. Saville Kent, late Curator of the Brighton Aquarium. Unfortunately, during the delay that has subsequently occurred in the development of the scheme, Mr. Kent has been induced to accept the curatorship of the Manchester (England) Aquarium.

But of what use, it may be asked, other than embellishment, is the aquarium? The scientific reader, knowing its value, will not require an answer; but, to the unscientific, it doubtless seems of small practical use to spend time and money in gathering together a few fish and plants, that their growth and movements may be observed. The answer is, first, its scientific value. Its influence would be to engender in the thousands who would daily visit it a taste for scientific knowledge and pursuits. In seeing the objects it contained, people would naturally find a desire to know something of them beyond what can be learned by cursory observation, and thus be led to scientific reading and scientific education. Second, it constitutes a science by itself, and therefore demands the same encouragement that is given to any other one science. It is not yet half a century since Madame Jeannette Power began the study of marine animals, by the aid of glass cases filled with water, in which she confined them; still almost our entire knowledge of aquatic zoology having been obtained through the aquarium rests upon it. A striking result, recently obtained, is at least a partial settlement of the vexed question whether fish hear; the observations of Mr. Henry Lee on that subject, in the Brighton Aquarium, having determined that some fish certainly do hear.

In addition to these very cogent reasons is the fact that the aquarium is a never-failing source of interest. The objects it presents are, many of them, entirely new to human sight, and not a few are wonderfully beautiful. So great is the attraction of the aquarium, that, wherever established as a pecuniary investment, it has never failed to yield the most profitable results. Thus the aquarium at Hamburg has proved an immense pecuniary success; and that at Brighton, although beginning its existence so recently as August, 1872, has nevertheless already made a gratifying return to its proprietors.

Fig. 1.



Main Tank, Brighton Aquarium (Half-Section).

The aquarium further serves to illustrate an important biological truth—one of the most subtile relations between the animal and vegetable kingdoms. That truth is, that the two kingdoms exert complementary influences upon the atmosphere we breathe. Plants inhale carbon and exhale oxygen; animals do the reverse. Strike out all the plants from existence, and we should, poisoned by our own breath, die in heaps, with other animals; while, if all the animals could, at one blow, be swept away from the earth into space, the plants would be destroyed by the want of carbon. And now the aquarium, which, properly speaking, is an artificial sea, or lake, possessing all the conditions necessary to the maintenance of aquatic life, both animal and vegetable, beautifully illustrates this truth. Who has not observed that fish, confined in water without plants, quickly die, unless the water be repeatedly changed? The fish die because, having breathed out all the oxygen of the water, as there is nothing in it to produce any more, they become poisoned with the suffocating carbon. But, when the plants also are put in, they take up the carbon from the fish and go on producing oxygen all the while, so there is no longer any necessity for changing the water. The fact that marine aquaria do not require the introduction of plants has been supposed by some observers to furnish a contradiction of the truth just stated. But the contradiction is apparent only, not real. Sea, or "salt" water, as it is usually called, contains a great quantity of little germs or "spores," which quickly develop microscopic vegetation or *confervæ* upon the sides of the aquarium, and upon the rocks within it. This vegetation, although unobtrusive, performs all the work done by the more conspicuous plants of the fresh-water aquarium. The credit of inventing the aquarium proper has generally been given to Madame Power, before alluded to, who, in the year 1832 and thereabouts, while studying the marine animals on the coast of Sicily, brought into use the "water-cage" to facilitate her investigations. But Mr. W. Alford Lloyd, the present Curator of the Crystal Palace Aquarium, London, who is one of the highest authorities on the subject, contradicts that view. In an article published in *Science Gossip*, several years ago, he says that the introduction into the "water-cage" of "plants *for the avowed purpose stated beforehand*, of preserving the purity of the sea-water, and of sustaining the animals in health, is due to Mrs. Thynne, who experimented in London, in 1846, on living madrepores." Madame Power, it appears, was in the habit of changing the water in her cages. It would seem, therefore, that while to Madame Power belongs the credit of furnishing the clew to the scientific value of the aquarium, to Mrs. Thynne belongs that of inventing the aquarium itself.

Some interesting facts, not wholly of a zoological nature, have been observed through the aquarium. Thus it was ascertained that objects through the medium of water appear shorter than they really are. At the distance of a few feet, a fish, or other object, appears about one-fifth shorter than it is. Mr. Lloyd, through *Science Gossip*, has made known some curious effects of electricity on fish. A friend of his had a large fresh-water garden-aquarium. One day, during a thunder-storm, a house, about 200 feet from the aquarium, was struck by lightning. At the moment of the flash, all the fish in the aquarium, forty-three in number, of various kinds, were suddenly suspended perpendicularly, heads downward, with their tails at the surface of the water, in which position they feebly and vainly endeavored to swim to the bottom of the tank. "The manner in which the eels were almost jerked out of their hiding-places, in the sand at the bottom of the tank, was very remarkable. In less than half an hour forty-one were dead, strongly curved, almost in the form of semicircles, and fast decomposing; but two gradually recovered, by being placed in running water. It is well known that when fish become sick and die, under ordinary circumstances, they turn belly upward, horizontally, instead of having nose downward, as in this case."

These facts sufficiently indicate the utility of the aquarium, and the necessity for having one at Central Park. As an indication of the interest commanded by the subject in England, it may be mentioned that Mr. Kent has begun a series of lectures at Manchester, to show how it subserves the purposes of scientific instruction. The first lecture was delivered on the last Friday in June to a fairly numerous audience, and another will follow on every Friday afternoon during the summer.

One of the largest and most successful aquaria anywhere is that at Brighton, England. It is a private enterprise, and of very recent origin. It was originated by Mr. Edward Birch, an English engineer of note, who organized a stock company with a capital of $400,000. The work of construction was begun in 1869, and the building was formally thrown open to the public in August, 1872. The building stands upon the sea-beach, in front of the Marine Parade, its roof being a little below the level of that promenade. It has a total length of 715 feet, with a width of 100 feet. The interior is divided into two corridors, on either side of which stand the tanks containing the fish. The dominant style of architecture is the Italian, and highly ornate. The roof of the corridors is arched and groined, "constructed of variegated bricks, and supported on columns of Bath stone, polished serpentine marble, and Aberdeen granite. The capital of each column is elaborately carved in some appropriate marine device, while the floor, in correspondence, is laid out in acrostic tiles." The tanks number forty-one. Their fronts are made of plate-glass, one inch thick, divided into sheets three feet wide and six feet high, supported by upright iron mullions. At the eastern end of the west or main corridor is a fernery, with rock-work and cascade. Many of the tanks are also supplied with ornamental rock-work. For the accommodation of visitors there are a restaurant, dining-hall, and reading-room, in the building. The smallest tank measures 11 feet long by 10 broad, and contains about 4,000 gallons of water, while the largest measures 130 feet long, 30 broad, and holds 110,000 gallons. The latter is large enough to accommodate a small whale. At present, however, it contains only a porpoise, a few dog-fish, a ray, and several turtle. Six tanks are devoted to fresh-water animals, the rest to marine. The water of the latter is pumped up from the sea by steam when needed, but is never changed in any of the tanks except when required by turbidity, or any accident, such as the cracking of a front. To secure abundant aëration each tank is supplied with several vulcanite tubes, entering at the top and descending to the bottom. An air-pump, situated at one end of the building, and worked by steam, forces a stream of air into the tank through each tube. The result is, a constant bubbling up of the water. This plan, however, does not seem to be as desirable or efficient as the circulatory system maintained at the Crystal Palace Aquarium. This consists in merely pumping the water by steam up to a higher level, and allowing it to return, by force of gravity, through the tanks to the reservoir beneath. In its course it takes up a greater amount of oxygen than can be otherwise imparted to it, and at the same time acquires great clearness and brilliancy.

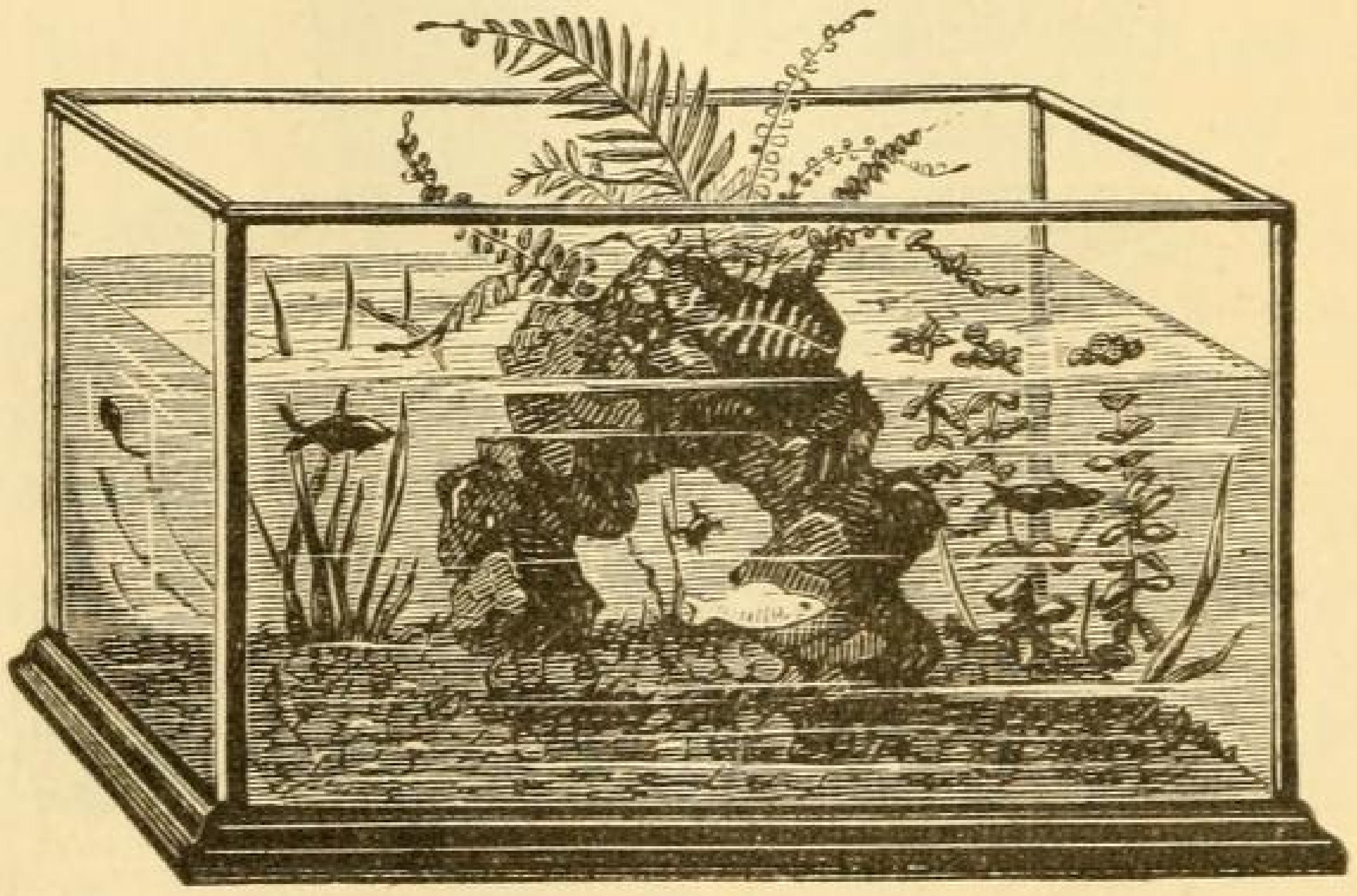
The best kind of vessel for a small aquarium is an oblong tank made of slate, with a glass front. Glass may be used instead of slate, but the latter is desirable, because it is important that the light received into the aquarium should be admitted from above, while the dark sides and back give a more natural appearance to the occupants. The framework, if of iron, should be plated to prevent its rusting, as that would injure the plants and animals. If the parts are cemented, Portland cement should be used, as it is freer from impurities than other cements; however, even it should be soaked in water for several days previous to using. In the form of an aquarium, superficial area

FIG. 2.

CHEAP AQUARIUM.

is more important than depth, because, the larger the surface in proportion to the depth, the greater will be the quantity of oxygen absorbed by the water. For household purposes, the cheapest and most convenient vessel for a small aquarium is the common bell-shaped glass used by confectioners to cover cakes. When this is used, green paper should be pasted upon the outside, except on the front, from the level of the water to the bottom. For marine aquaria the bottom should rise a short distance from the front, and continue in an inclined plane to the surface of the water. The bottom of the aquarium should be covered with a layer of sand from one to two inches thick, upon the top of which should be placed a few pebbles, in patches. For marine aquaria, the sand must be procured from the sea-beach, or a river-side, below the tide-mark, and, for those of fresh water, from the bed of a brook or running stream, and, in either case, it must be thoroughly washed, to free it from impurities. Rock-work may be built upon the sand, to form caves and grottoes, but there should not be any hiding-places for impurities to collect in. A pleasing effect is secured by building the rock-work above the surface of the water, and making a small hollow in the top, where a fern may be planted. The rock should be taken from the sea, or the brook, according as it is wanted for the marine or fresh-water aquarium, the object being to make the artificial home of the animals as much as possible like their natural one. In constructing the rock-work, Portland cement should be used, and it should be allowed to harden before the water is poured into the tank. The water should be poured off several times, until it remains quite clean, and the greatest care should be taken to prevent the addition of impurities with any object. The plants must be stuck into the sand with a pebble tied to the roots of each to hold it in position, and they should be arranged to produce a pleasing effect, as individual taste may dictate. After the plants have taken root, the animals may be added. If both forms of life be present in proper proportions, there will be no necessity for change or disturbance of the water, but, if they be not, artificial aëration will be required. When this is needed, the

Fig. 3.

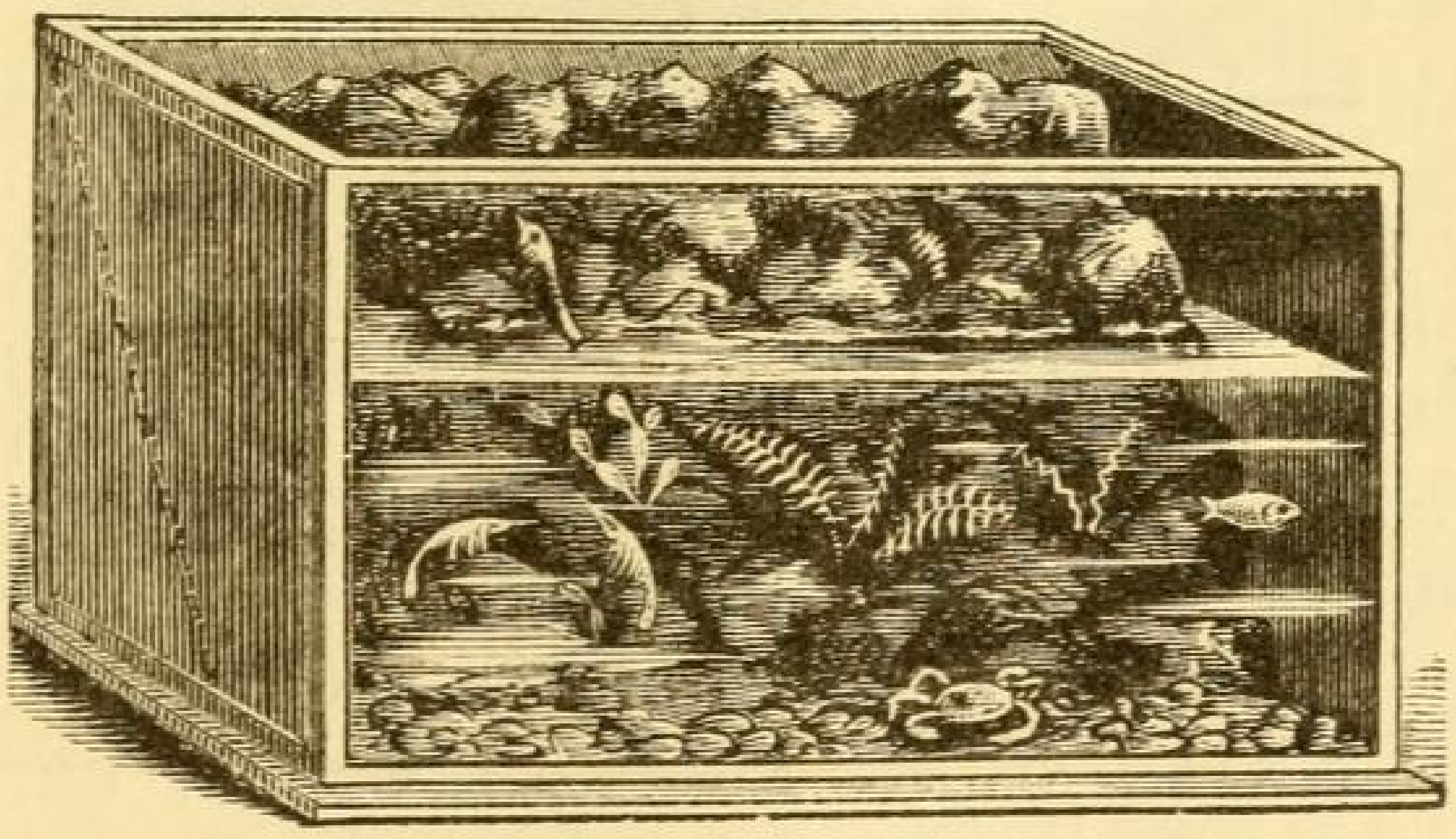


Fresh-water Aquarium.

fish will repeatedly rise to the surface and stick their noses out to catch a breath of oxygen. Aëration may be effected in lifting the water by cupsful, and allowing it to run back gradually from a point two or three feet above. This process should be continued for a half-hour or more at a time, once or twice a day. The ordinary level of the water should be indicated by a mark on the glass-front, so that loss from evaporation can be detected and supplied. Great care must be taken to secure uniformity of temperature, between 45° and 65° Fahr. For this purpose an east window should be chosen where the sun can be had for two or three hours every morning. In summer the window should be opened, and in the winter evenings the tank drawn back into the room. A south window may be used for the aquarium if care be taken to shade off the noonday sun. When the water at the bottom of the tank becomes impure from the accumulation of sediment, it may be drawn off by a siphon (of rubber tube) without disturbing the water above, after which the tank must be filled up again with pure water. For the purpose of removing large substances from the bottom, a pair of wooden forceps—glove-stretchers will do—are required. Light particles, such as uneaten food, decayed leaves, etc., can be removed by placing against them one end of a small glass tube, and covering the other with a finger. The aquarium should be kept as clean as possible, all dead plants or animals being at once removed.

The best plants for fresh-water aquaria are the spiral *Valisneria*, a native of Southern Europe, and not easily procurable; the American water-thyme (*Anacharis alsinastrum*); the common frogbit (*Hydrocharis morsus-ranæ*), which, being of different form from the others, will give variety in appearance; the arum (*Calla palustris*); common stonewort (*Chara vulgaris*); water-soldier (*Stratiotes alvidies*); spiked water-milfoil (*Myriophyllum spicatum*); small water-lilies (for larger tanks), white (*Nymphea alba*), and yellow (*Nuphar luteum*). A little duckweed (*Lemna minor*) may be added, as it floats about and harbors minute insects which the fish eat. In choosing animals for the same, the golden carp is most desirable for its beauty, the minnow for interest and longevity. The latter should be examined before admission

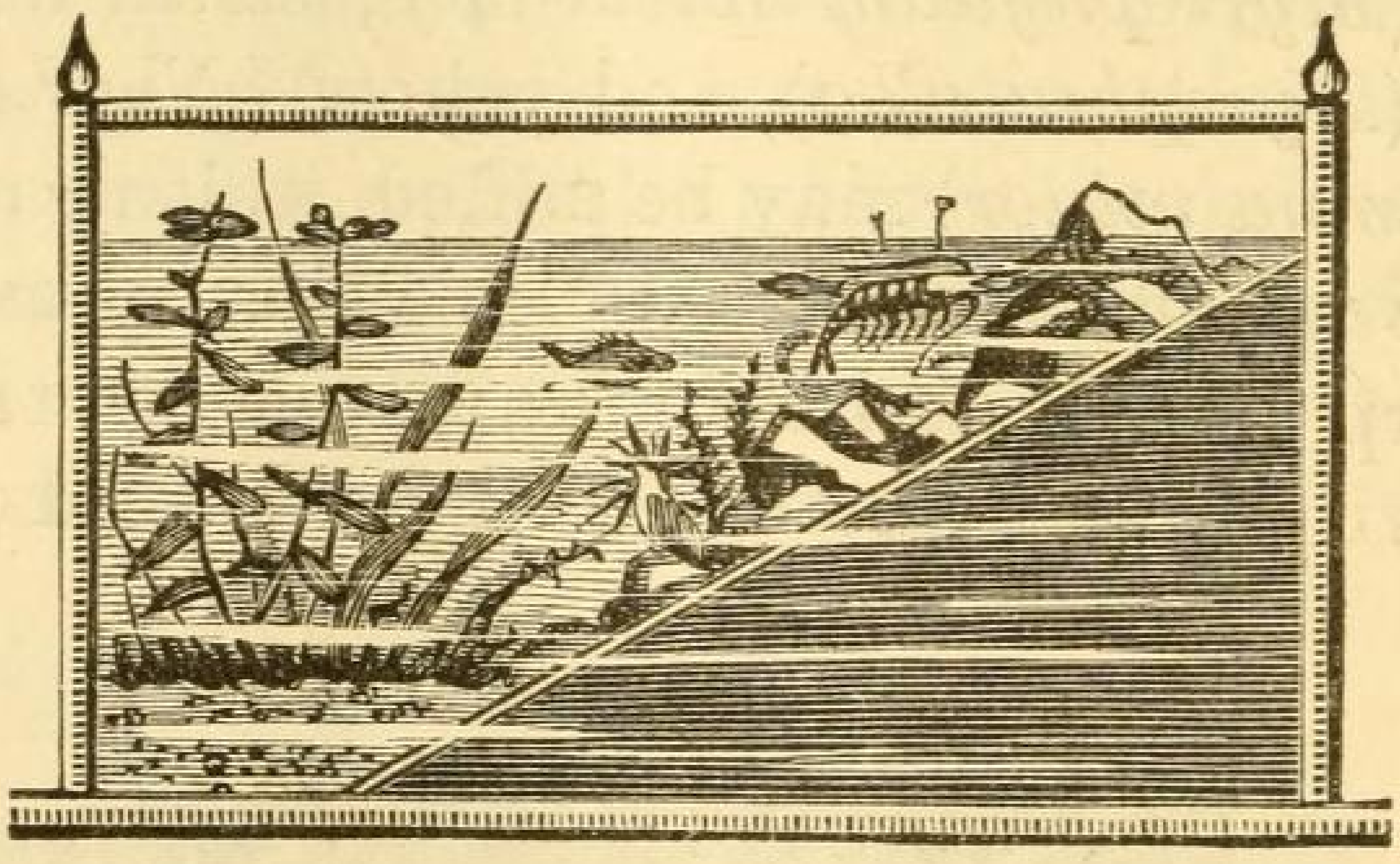
Fig. 4.



Marine Aquarium (Front View).

and rejected if a white downy spot is observed near the tail, as that is an indication of disease. The loach, the common carp, Prussian carp, roach, tench, and gudgeon, may be admitted, but the first three are preferable to the last. The common tadpole possesses considerable interest in its development into the frog. The small newt and the triton are objects of interest and quite harmless. The latter has a bright-yellow body striped with black. When amphibious animals, such as the newt and frog, are kept, the rock-work must rise above the surface of the water, as these animals require a resting-place above water. Small floats may be prepared for them by smearing a cork with marine glue and sprinkling it with sand. When the glue has dried, place the float in water and allow it to remain there for some time before putting it into the aquarium. These animals have also a disposition to rove, which must be checked by covering the aquarium. The cover should be of glass and flat, with a large opening in the centre. The cover is also advantageous to keep out dust. Molluscous animals, as the horny coil-shell (*Planorbis corneus*) and the pond mud-shell (*Limnea stagnalis*), may be added. They are both to be found among the grasses that grow in ponds and on the margin of brooks. Such insects as the common water-spider (*Argyroneta aquatica*), the large harmless beetle (*Hydroüs piceus*), and the little whirligig (*Gyrinus natator*), can be introduced to advantage. Pugnacious individuals, as the perch and the stickleback, though interesting, are not desirable objects for a general aquarium. The best food for the animals described is a little biscuit-powder kneaded into pills about the size of a pin-head and fine shreds of raw beef cut with scissors. The first should be fed once a day, the biscuit and meat being thrown in bit by bit alternately.

FIG. 5.



MARINE AQUARIUM (Side View).

The marine aquarium must be supplied with sea-water taken not less than a mile from shore, or from the middle of a large river. When any is lost from the tank *by evaporation*, add fresh rain-water to supply the deficiency; losses otherwise occasioned must be made good by the addition of sea-water. Among the most curious and interesting animals are the shrimp or prawn; the smooth anemone (*Actinia mesembryanthemum*), one of the hardiest and most curious animals that can be found; the limpet (*Patella vulgaris*), with its shelly parasite the barnacle (*Balanus*); the hermit-crab (*Pagurus Bernhardus*); the stone-crab (*Cancer pagurus*); the smaller star-fish; and the tube-worm (*Surpulæ*). In introducing fish, care should be taken to select the most amicable; a small shark, for instance, was once introduced into the aquarium of the Emperor William, at his country-seat in Prussia. The effect was, that all the other fish forsook the tank, and fled in great confusion into a fresh-water one adjoining, nor could they be driven back until the shark was removed. The best food for the animals indicated is the mussel or the oyster cut into fine shreds, but fresh beef may be used if these cannot be had. To feed the anemones, place a shred upon the end of a stick and put it in contact with one of the animal's tentacles, whereupon it will be immediately conveyed to the mouth. They do not require feeding oftener than once a week. The crabs should be fed at the same time or they will rob the anemones. It is not necessary, as previously indicated, to add plants to marine aquaria; however, a few pieces of sea-weed may be put in for the sake of ornament, but, as it does not live long, care should be taken to remove each piece as soon as it dies, and replace it by a living one.

THERMAL DEATH-POINT OF LIVING MATTER.[1]

By H. CHARLTON BASTIAN, M.D., F.R.S.,

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I.

WATER is boiling merrily over a brisk fire, when some luckless person upsets the vessel, so that the heated fluid exercises its scathing influence upon an uncovered portion of the body—hand, arm, or face. Those who have seen much of the effects produced upon the human skin by such accidents, will have acquired information not unworthy of influencing their opinion on some more general problems connected with the action of heat upon living matter. Here, at all events, there is no room for doubt. Boiling water unquestionably exercises a most pernicious and rapidly destructive action upon the living matter of which we are composed. There is no need to appeal to the sufferer's sensations for this information. This, indeed, is a point of view which we may for the present dismiss. For, however agonizing these sensations may be, they could only supply us with information upon a collateral point with which we are not at present concerned. Apart from such subjective effects, there are objective effects. That is, we are easily able to see the changes produced by boiling water upon living matter—revealing themselves as they do by an immediately altered appearance of the skin, and by the terrible wound so quickly produced. Upon these distressing, though, unfortunately, only too familiar consequences of the action of heat upon living matter, it is not necessary for me further to dwell; I would merely have the reader so far bear them in mind that they may not be incapable of recall during the perusal of this article. The occasional revival of such impressions may perhaps prove a little

[1] From author's advance sheets.